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Introduction

This document describes the Utility Suite Diagnostics, provides operating instructions, lists error messages and describes how to interpret those messages.

Software Compatibility

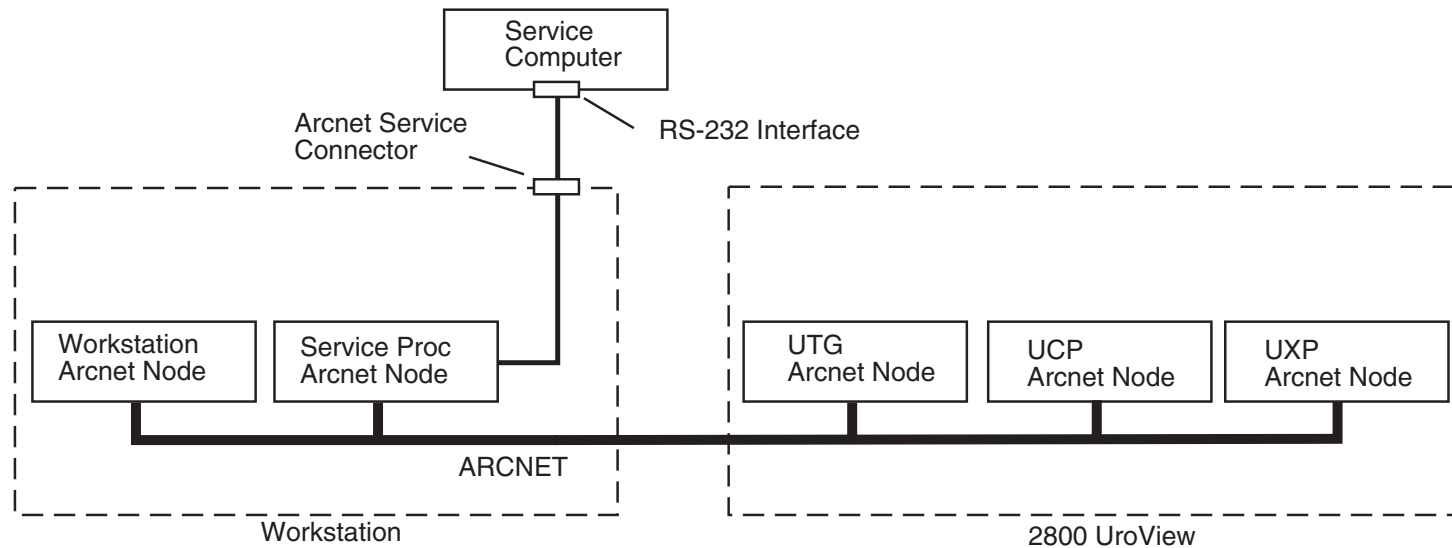
To determine if these diagnostics can be used to troubleshoot a system, perform the following:

1. Check the Software Part Number by booting the Workstation and pressing the Help button.
2. Locate the Software Part Number and use the following table to determine if the diagnostics will operate with the system in question.

Workstation Software P/N	Diagnostic Operational Status
00-883783-09 and later	Verified
00-883783-05 thru -08	Not verified
00-879130-04 thru -12	Pre-OPIS system. Utility Suite cannot connect.

Arcnet Communication

The key to 2800 diagnostic software is the Arcnet communications connecting each node (processor) in the system. The Interconnect Diagram shows the five Arcnet nodes found in a 2800 system and their connection to a Service Computer.



Interconnect Diagram

Utility Suite Diagnostics

The 2800 system contains five microprocessors each containing an Arcnet “node”. A “node” is a microprocessor with software/hardware support. Nodes communicate with each other using the Arcnet Communication Protocol. Each processor performs functions specific to that node. Each of the nodes contains “support software” that allows the system diagnostics to run.

Workstation (WS) Node

The Workstation displays images obtained from the camera. The Workstation also displays technique settings obtained from the X-ray Controller (via Arcnet) and displays the technique as shots are taken.

Service Processor (Snode) Node

This node, physically located on the Systems Interface PCB within the Workstation electronics enclosure, provides a “gateway” between the system Arcnet and the Field Service Computer. The Service Computer sends commands to the Service Processor via RS-232 serial communication (special cable required). The Service Processor then places the command packet on the Arcnet for one of the other nodes. Response packets from the other nodes are changed into RS-232 format by the Service Processor and returned to the Field Service Computer.

Universal Table/Generator (UTG) Node

The UTG node is located near the Table/Generator Interface PCB and consists of an ISA Half Size CPU. Table and Generator communication is conducted via this node.

Universal Control Panel (UCP) Node

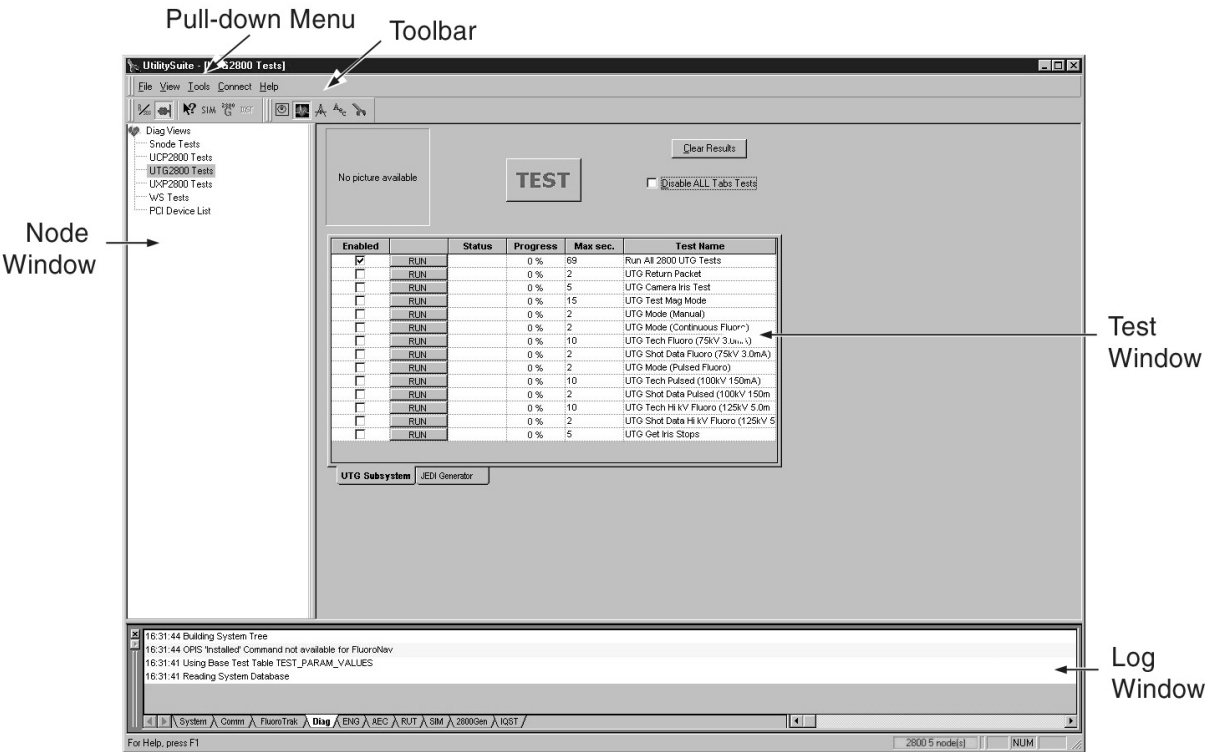
The UCP node is located within the collimator housing and controls mechanical components such as the collimator iris, leaf open/close, leaf rotation, camera, etc.

Universal X-ray Control Panel (UXP) Node

The UXP node is located within the X-ray Control Console and is comprised of an ISA Half Size CPU. Communications (commands) to the Table and Generator are conducted via this node.

Diagnostic Screen Functions

All Utility Suite Diagnostic Screens have similar features. They all have Pull-down Menus, Toolbars, Node Window, Test Window and a Log Window. Each feature is described below.



Example of a Utility Suite Diagnostic Screen

Pull-down menus/Tool Bar

Pull-down menus provide access to all the commands available in the Utility Suite. The Toolbar provides a shortcut to many of the commands available through the Pull-down Menus. Any or all of the following icons can be displayed based on the security level of the person using the Utility Suite, the modules installed on the PC, the current connection state, and the product type of the connected X-ray system. Each Toolbar icon has a tab related to the corresponding module, located in the Log Window.

Icon	Module Name	Related Tab in Log Window	Module Description
	AEC Module	AEC	Makes AEC Calibration functionality available.
	DAP Module	DAP	Makes DAP Calibration functionality available.
	Engineering Module	ENG	Makes Engineering-specific functionality (currently OPIS Test functions and Terminal Emulator) available.
	DIAG Module	DIAG	Makes Diagnostics available.
	RUT Module	RUT	Makes RUT Configuration functionality available.
	TERM Module	TERM	Makes Terminal Emulation functionality available. This is a security-level limited version of the Debug monitor and Test Utility menu.
	Generator Install	2800GEN	Launches a Generator Software Installation Wizard capable of backing up and restoring AEC Calibration Data, retrieving the Generator Configuration database and installing new software.

Icon	Module Name	Related Tab in Log Window	Module Description
	Software Installation Manager (SIM)	SIM	Launches a Wizard that walks the user through installation and upgrading of released X-Ray system software.
	Connect to Dosimeter	COMM	Establishes a serial connection to an attached Dosimeter.
	Connect to System	COMM	Establishes a serial connection to the serial Arcnet port on the Workstation and communicates with the Service Node.
	IQST	IQST	Launches the Image Quality Signature Tool (IQST) wizard.

Node (Tree) Window

The Node Window displays, in tree structure, the nodes in the system. All five nodes should be visible in this window. If they are not, a problem with the missing node may be indicated. Once testing has begun the node window will show, in tree structure, the subcomponents that are tested with respect to that node and whether they pass or fail.

Test Window

The Test Window displays the tests that can be performed, relative to which node is selected in the Node Window. Enable a test by placing a checkmark in the checkbox beside the test. To execute multiple tests, place a checkmark beside each test you want to perform and then click the Test button. To execute an individual test, click the Run button beside the test.

The Test Window also displays tabs at the bottom of the window. The tabs indicate subcomponents of the currently selected node that can be tested. There may be one tab or multiple tabs displayed.

Log Window

The tabs at the bottom-left of the Log Window provide access to different logs. The tab that is highlighted indicates the log you are currently viewing. Two logs provide useful information when performing diagnostics: they are the Diag (Diagnostics) log and the Comm (Communication) log.

The Diag Log is the primary log you will want to view when performing diagnostics. The Diag Log displays a log of completed tests, a real-time log of the test currently running and codes and error messages if a test fails. The Diag tab is the default log when the Utility Suite Diag icon is selected.

The Comm log shows communication activity and displays error messages if communication fails. For example, if the connection between the Utility Suite software and the system is broken, a message will be reported in the Communication Log stating the connection was lost.

Diagnostic Testing

Tools

Utility Suite Software, Level 2, OEC P/N 00-884049-XX

Laptop computer

Serial cable 00-901559-XX

Setup

1. Load the Utility Suite software onto your laptop and connect the serial cable between your laptop and the Workstation.
2. Boot the System.

Note: If either the Workstation or Table/Generator fail to boot, refer to the next section: Boot-up and Connection Problems.

3. Start the Utility Suite software.
4. Click on the Connect pull-down menu and select System.

Note: The software will establish communication with the system. A message at the bottom-right of the screen should indicate that all 5 Nodes are on-line. If you are unable to connect with the system, refer to the next section: Boot-up and Connection Problems.

5. Click the RUT icon (wrench) and retrieve and save the system's configuration data.
6. Click the Diag icon.
7. Go to the section in this document that corresponds with the subsystem you want to test.

Boot-up and Connection Problems

If you encountered boot-up or connection problems review the following table for help. If the system completed boot-up and you connected using the Utility Suite continue on to Diagnostic Testing.

Symptom	Action
Workstation fails to boot	Check the circuit breakers. If WS power indicator is on but monitors never illuminate, connect diagnostic monitor to rear monitor port if possible and read display. If the Single Board Computer (SBC) appears to be dead (e.g. nothing is displayed on the diagnostic monitor), check that all appropriate LED's on the DC Distribution PCB are lit. (Depending upon system configuration, they may not all be lit. DS9 is normally not lit). If an LED is out, the fuses should be tested with an ohmmeter. Improper connection (swapping) of power cables can impair proper boot-up. Ensure that the power cables are connected to the correct PCB's. Power cables are not interchangeable. Verify that the CPU Fan is rotating. If the SBC has power but the fan is not rotating, perhaps because the fan power connector has come loose, then the SBC should be replaced, since the CPU has likely overheated and failed. If it has operated for any significant time without the fan operating, even if the CPU has not failed, then CPU reliability has been seriously compromised and the SBC should be replaced. If the diagnostic monitor is blank, it may be possible that the video cable on top of the SBC is loose. Check voltage levels to the SBC. These should be +5V and +12V nominally. These can be checked at the black terminal strip on the backplane PCB. Ensure that the SBC is fully seated in the backplane, and that the SBC edge connector fingers appear to line up properly with the edge connector pins on the backplane. If voltages are correct but the SBC does not appear to operate, check the high-density ribbon cable connecting the IP PCB to the Video Control PCB. If this cable is loose or not connected, then the system clock signal does not get routed to the IP, causing it to hang the PCI bus. If this is not the source, try removing each of the PCB's plugged into the backplane one at a time and reapplying power after each PCB removal. If the system begins to start booting after removal of a PCB, then the PCB may have a short or defective chip causing the processor bus to hang. If a particular PCB is narrowed down as preventing system boot, replace the offending PCB. If none of these yield results, replace the SBC.

Symptom	Action
Table/Generator fails to boot	Check AC power. Check circuit breakers. Check DC power supplies. Refer to the 2800 UroView Service Manual for related functional tests and diagnostic procedures.
Utility Suite fails to connect to the system (The five nodes are not displayed in the Node Window)	If the Workstation software is pre-OPIS the Utility Suite cannot connect and these diagnostics cannot be used. See the Software Compatibility section in this document for additional information. If the Service Node, located on the System Interface PCB (SI) is not operating properly, then no diagnostic testing will be possible. The possible causes might be: External RS-232 cable problems Interconnection problems to the System Interface (SI) PCB Physical defect on SI PCB The power cables to the PCB's, connected to the backplane, have the same connectors and appear to be interchangeable, but are not. Improper connection (swapping) of power cables can impair proper boot-up. Ensure that the power cables are connected to the correct PCB's. Connection / cabling problems should be suspected and dealt with before replacing the SI PCB, especially if the system boots properly. Ensure that the top ribbon cable on the SI PCB is properly connected. This cable carries power to the SI PCB, and proper operation will not be possible if it is not plugged in properly.
Utility Suite/System connection is lost while testing	A test failure can cause a software disconnect. If this happens verify that there are no other potential causes of the software disconnect. Reconnect to the system and rerun the test that was executing when the failure occurred. If the software disconnects again, conclude that the test failed.

Debug Error Log Retrieval

Error messages from the Utility Suite Diagnostics are recorded on the Workstation IDE Hard Drive in the DEBUGLOG.TXT file. This file can be retrieved for Technical Support by copying the file onto a 3.5-inch diskette using the DOS command set.

1. Install a keyboard using the keyboard connector in the back of the Workstation.
2. Boot the system from the Workstation Boot Disk.
3. Remove the Boot Disk and insert a DOS formatted 3.5-inch diskette.
4. On the keyboard type:
Copy C:\debuglog.txt A:
5. Remove the floppy diskette.

Service Node (Snode) Tests

Service Node tests are performed during product burn-in (the manufacturing environment) only. If you are able to connect with the system then the Service Node is functional. If you have trouble connecting with the system, refer to the *Boot-up and Connection Problems* section in this document.

UCP2800 Tests

Review the test descriptions, perform the diagnostic tests and if a failure occurs refer to the error codes and perform the actions described there.

Test Descriptions

The following table describes tests performed by the UCP Node in response to a command from the Service computer.

Test	Description
UCP Req. SW Ver	The Service computer may issue this command to request the UCP software version. The value of the software version is embedded in the UCP software when the software is built and cannot be altered.
UCP Return Packet	The Service computer may issue this command in order to determine if the UCP node is operational. Furthermore, this function may be used to implement a “ping” function to determine reliability of the Arcnet communications.
UCP Test Collimator	The UCP collimator test provides testing of the motors located on the Collimator. The following topics describe the test algorithms used for the motor tests.

Test	Description
UCP Collimator Latitude Test	When this command is issued to the UCP by the Service Computer, the command contains two values that represent the minimum and maximum time (in milliseconds) allotted for the latitude motor to travel to from fully opened to fully closed. The same minimum and maximum values also apply when opening the iris. The UCP first verifies the collimator latitude has been calibrated. If not, the error message “Coll Latitude Not Calibrated” is returned to the computer initiating the command. The latitude motor is first commanded to the fully open position before time testing starts. The latitude motor is timed while closing and then timed again while re-opening. If either the open or close time min or max limit is exceeded, the error message “Coll Latitude Close Failure” or “Coll Latitude Open Failure” is returned to the initiating computer. The response packet to the initiating computer contains the error code plus two measured values — the time (in milliseconds) taken to close and the time taken to open. The initiating computer can display those values, in conjunction with commanded minimum and maximum time so that an operator can determine the type of error. If the collimator latitude motor fails to move at all or is sluggish, the returned time will be very slightly longer than the maximum time. Note that this test temporarily replaces the NORMAL magnification mode and MAG 2 mode calibrated iris positions with the physical stop values, performs the test and then restores the NORMAL and MAG2 values. However, due to this methodology, a COLLIMATOR STUCK error message may be displayed on the Control Panel. Note that this message is a system error message generated by the UCP PCB.

Test	Description
UCP Collimator Longitude Test	When this command is issued to the UCP by the Service Computer, the command contains two values that represent the minimum and maximum time (in milliseconds) allotted for the longitude motor to travel to from fully opened to fully closed. The same minimum and maximum values also apply when opening the iris. The UCP first verifies the collimator longitude has been calibrated. If not, the error message “Coll Longitude Not Calibrated” is returned to the computer initiating the command. The longitude motor is first commanded to the fully open position before time testing starts. The longitude motor is timed while closing and then timed again while re-opening. If either the open or close time min or max limit is exceeded, the error message “Coll Longitude Close Failure” or “Coll Longitude Open Failure” is returned to the initiating computer. The response packet to the initiating computer contains the error code plus two measured values — the time (in milliseconds) taken to close and the time taken to open. The initiating computer can display those values, in conjunction with commanded minimum and maximum time so that an operator can determine the type of error. If the collimator longitude motor fails to move at all or is sluggish, the returned time will be very slightly longer than the maximum time. Note that this test temporarily replaces the NORMAL magnification mode and MAG 2 mode calibrated iris positions with the physical stop values, performs the test and then restores the NORMAL and MAG2 values. However, due to this methodology, a COLLIMATOR STUCK error message may be displayed on the Control Panel. Note that this message is a system error message generated by the UCP PCB.
UCP Return Collimator Position	This test is used to obtain the position of the collimator. This test should not be called on its own.
UCP Display Message	The Service computer may issue this command in order to display a message on the Control Panel. No response message is returned to the initiating computer when the UCP receives one of these commands.

Diagnostic Testing

CAUTION: If you have executed any Workstation tests, reboot the system before performing Table/Gen tests.

1. Perform the Setup instructions provided at the beginning of this document.
2. Select UCP2800 Tests from the Node Window.

Note: If the Disable ALL Tabs Tests checkbox is selected, the tests are disabled.

3. Click the Test button to execute all the checked tests.

Note: To stop testing, click the STOP button.

4. View the test results in the Log Window.
5. If a failure is indicated refer to the error codes in the following table and perform the actions described there.
6. Failed tests can be executed individually by clicking the Run button beside the test.

Note: To clear the results, click the Clear Results button.

Note: Individual tests can be executed by clicking the RUN button that corresponds to the test.

Error Codes

The UCP, in response to a command from the Service Computer, generates these error codes.

Code	Message	Description	Action
2901	Illegal UCP Cmd Received	The command received was not a legal command.	This indicates a possible software incompatibility between the Utility Suite and the System Software. Please check to see that the versions are compatible.
2902	Illegal UCP Cmd Received	The command received by the UCP contains an invalid code.	This indicates a possible software incompatibility between the Utility Suite and the System Software. Please check to see that the versions are compatible.
2903	UCP System Failure	Refer to the error message displayed on the Control Panel VFD.	Obtain the error message from the VFD and refer to the Diagnostics section of the 2800 Service Manual for further troubleshooting.
2904	UCP Collimator Cal Required	The collimator requires calibration. Follow the proper procedures to perform this operation.	Re-calibrate the collimator or download the calibration files.
2905	UCP Lat Collimator Close Fail	The Collimator Lateral movement does not close in the specified amount of time.	Verify that the collimator wiring is OK and that the lateral movement does not bind.
2906	UCP Lat Collimator Open Fail	The Collimator Lateral movement does not open in the specified amount of time.	Verify that the collimator wiring is OK and that the lateral movement does not bind.

Code	Message	Description	Action
2907	UCP LON Collimator Close Fail	The Collimator Longitudinal movement does not close in the specified amount of time.	Verify that the collimator wiring is OK and that the lateral movement does not bind.
2908	UCP LON Collimator Open Fail	The Collimator Longitudinal movement does not open in the specified amount of time.	Verify that the collimator wiring is OK and that the lateral movement does not bind.

UTG2800 Tests

Diagnostics are available for the UTG Subsystem and the Generator Subsystem. Select a subsystem to test by selecting the corresponding tab at the bottom-left of the Diag Test Window.

UTG Subsystem

Test Descriptions

The following table describes tests performed by the UTG Node in response to a command from the Service computer.

Test	Description
UTG Req. Barcode	The Service computer may issue this command to request the UTG barcode value. The value of the barcode can only be set using the <i>Remote Utility Tools</i> .
UTG Req. SW Ver	The Service computer may issue this command to request the UTG software version. The value of the software version is embedded in the UTG software when the software is built and cannot be altered.
UTG Req. Gen SW Ver	The Service computer may issue this command to request the UTG software version. The value of the software version is embedded in the Generator software when the software is built and cannot be altered.
UTG Return Pac	The Service computer may issue this command in order to determine if the UTG node is operational. Furthermore, this function may be used to implement a “ping” function to determine reliability of the Arcnet communications.

Test	Description
UTG Set X-ray Mode	The Service computer may issue this command to place the generator in one of the following modes: AUTO MANUAL FILM CONTINUOUS_FLUORO PULSE_FLUORO DIGITAL_CINE The Generator does not return a response packet to the computer initiating this command. It simply performs the command.
UTG Set Technique	The Service computer may issue this command to set the technique and, in the case of pulsed shots, the pulse rate. The Generator does not return a response packet to the computer initiating this command. It simply performs the command.
UTG Return Shot Data	The Service computer may issue this command to obtain technique information (kV, mA/mAs, and VLI) from the generator for the last shot taken. Based on the desired technique, the Computer determines if the shot passed or failed by comparing the measured kV, mA/mAs and VLI to the expected values. If any system error occurred prior to the shot or during the shot, the error message UTG_SYSTEM_FAILURE is returned to the initiating computer. That error message is caused if one of the system error messages is displayed on Generator's Control Panel (e.g. "LOW MA"). A separate error code representing the actual system error code (in this case LOW MA) is also returned to the initiating computer. If a system error occurs during a shot, the mA/mAs, kV and VL values may not be valid.

Test	Description
UTG Camera Iris Test	When this command is issued to the UTG by the Service Computer, the command contains three values: Maximum time (in milliseconds) allotted to open or close the camera iris Minimum difference in position between fully open and fully closed Maximum difference in position between fully open and fully closed The importance of knowing the difference in position of the camera iris stop settings is that those settings affect dose rate (therefore, image quality). The physical camera iris stops are factory adjusted to provide a range of two f-stops. This test not only ensures the iris moves from stop to stop within the maximum allotted time but also that the physical open and closed positions provide two f-stops of adjustment. When this command is issued to the UTG, the UTG first determines where the physical stops of the iris are set. If the UTG fails to find the fully closed and fully open stops within the allotted time, the error message “Camera Iris Limits not Found” is returned to the initiating computer. Failure to find stops is typically caused by a broken motor wire, excessive friction on the iris gear, or broken iris potentiometer wire. Any of those will cause the limit error. Note that this error represents an error in the time domain. Therefore, the response packet returned to the initiating computer will contain the error code and a value slightly larger than the maximum time. The UTG then calculates the difference between the fully open and fully closed potentiometer readings. If that difference is not within the minimum and maximum difference in position values provided by the initiating computer, one of the following messages is generated: “Camera Iris Stops Too Small” or “Camera Iris Stops Too Large”. Those errors indicate misadjusted iris stops. Since these errors are in the “distance domain”, three values are returned to the initiating computer. Those values are: The error code The fully closed position reading The fully opened position reading The user can calculate the difference between those values and determine how far out of specification the stops have been set. The iris is again tested in the time domain by closing and opening the iris and verifying stop-to-stop movement occurs within the maximum time. Failure to reach the limits within the maximum amount of time will cause the error messages “Camera Iris Close Failure” or “Camera Iris Open Failure.” Functionally, the Camera Iris Limits not Found, Camera Iris Close Failure and Camera Iris Open Failure error messages are reported for the same reasons.

Test	Description
UTG Toggle Mag Mode	When this command is issued to the UTG, the UTG switches from the current magnification mode to the next one in the list (NORMAL, MAG1, MAG2 then NORMAL).
UTG Mag Mode Test	When this command is issued to the UTG, the UTG issues a simulated key press to the Pausch table commanding it to switch to MAG1, MAG2 then NORMAL mode. Three seconds after each change is issued, the UTG compares the selected mode reported by the table to the expected mode. If the MAG mode reported by the table does not match the expected mode, the corresponding error message, “II Normal Mag Fail”, “II Mag1 Fail” or “II Mag2 Fail” is returned to the initiating computer. Note that this test does not verify the Image Intensifier actually changes size, simply that the Pausch table relays are operating properly.
UTG Table Motion Test	This command tests the table motion of the UroView system. When the command is sent to the UTG, a time and an axis are sent. The time is the allotted amount of time for the table to move in the specified direction. There is no feedback to the Service Computer so there is no way to know if the table reaches the desired destination.

Diagnostic Testing

CAUTION: If you have executed any Workstation tests, reboot the system before performing Table/Generator tests.

1. Perform the Setup instructions provided at the beginning of this document.
2. Select UTG2800 Tests from the Node Window.
3. Verify the UTG Subsystem tab in the bottom-left of the Test Window is selected.

Note: If the Disable ALL Tabs Tests checkbox is selected, the tests are disabled.

4. Click the Test button to execute all the checked tests.

Note: You may select multiple tests by placing a checkmark beside each test and clicking the TEST button. Make sure that if there are tabs at the bottom-left of the Test Window that you click on each available tab and disable the tests that you do not want to execute.

Note: To stop testing, click the STOP button

5. View the test results in the Log Window.
6. If a failure is indicated refer to the error codes in the following table and perform the actions described there.
7. Failed tests can be executed individually by clicking the Run button beside the test.

Note: To clear the results, click the Clear Results button

Error Codes

The following error codes, are reported by the UTG node, in response to a command from the Service Computer.

Code	Message	Description	Action
2801	Illegal UTG Cmd Received	The command received was not a legal command.	This indicates a possible software incompatibility between the Utility Suite and the System Software. Please check to see that the versions are compatible.
2802	Illegal UTG Cmd Received	The command received by the UTG contains an invalid code.	This indicates a possible software incompatibility between the Utility Suite and the System Software. Please check to see that the versions are compatible.
2803	UTG System Failure	Refer to the error message displayed on the Control Panel VFD.	Obtain the error message from the VFD and refer to the Diagnostics section of the 2800 Service Manual for further troubleshooting.
2805	UTG Camera Iris Error	The camera iris does not have the proper span between the open and closed stop positions. Verify calibration and check to make sure the iris is not stuck.	Verify that the camera is calibrated properly. Also verify that the cabling between the camera and the UTG node is connected properly.
2806	UTG Table Motion Error	An error occurred during the table motion test.	Verify that the table is calibrated and that there are no loose or missing wiring connections.
2807	UTG Normal Mag Failure	The Normal Magnification Mode cannot be reached properly. Check system calibration.	Verify system calibration. Also verify that the cables comprising the magnification mode sub-system are all connected properly.

Code	Message	Description	Action
2808	UTG Mag1 Failure	The Mag1 Magnification Mode cannot be reached properly. Check system calibration.	Verify system calibration. Also verify that the cables comprising the magnification mode sub-system are all connected properly.
2809	UTG Mag2 Failure	The Mag2 Magnification Mode cannot be reached properly. Check system calibration.	Verify system calibration. Also verify that the cables comprising the magnification mode sub-system are all connected properly.

Generator Subsystem

Read the Test Descriptions section prior to running the diagnostic tests. Tests require that certain components are functional in order to execute the tests. Some tests require operator intervention.

Test Descriptions

The following table describes tests performed by the Generator in response to a command from the Service computer.

Test	Description
Run All 2800 GEN Tests	This selection executes all of the tests listed in this table. Note that the first two tests: GEN DIAG GATE CMD and GEN DIAG INVERTER require operator intervention.
GEN_DIAG_GATE_CMD Requires Operator Intervention	The purpose of this test is to verify that the HV power inverter drive is working properly. The IGBTs gate drive supply and the IGBTs gate drive is verified. At the same time verification is made that no inverter currents or high voltage are measured. This test is performed without DC voltage applied to the inverter so that no X-ray is generated. Anode rotation and filament drive are not activated during this test. The following components must be functional to execute this test: • Generator input line in an acceptable range (380V-10% to 480V+10% for 3-phase AC input) • PPC kV Control PCB alive and running: S0-S7 Leds are lit successively or a combination of them blink • Inverter gate_cmd board DC supply present: DS300 neon is lit

Test	Description
GEN_DIAG_INVERTER “In Short Circuit” Requires Operator Intervention	The purpose of this test is to verify that the HV power inverter is working properly. The inverter is commanded at a fixed frequency and is loaded with a short circuit. Verification is made that the inverter currents are correctly set. At the same time verification is made that no high voltage is measured. This test is performed without connecting the HV Tank to the inverter so that no X-rays are generated. Anode rotation and filament drive are not activated during this test. The following components must be functional to execute this test: • Generator input line in an acceptable range (380V-10% to 480V+10% for 3-phase AC input) • PPC kV control board alive and running: S0-S7 LEDs are lit successively or a combination of them blink • Inverter gate_cmd PCB DC supply present: DS300 neon is lit • Inverter Quad Snubber PCB DC supply present: DS1-DS2 led are lit • Inverter Gate Command diagnostic passed without failure
GEN_DIAG_NOLOAD_KV	The purpose of this test is to verify that the HV power inverter and HV tank are working properly. The exposure is taken as in application mode except that no filament drive nor anode rotation is running. Verification is made that the inverter currents are correctly set and that kV regulation is operating properly. As no filament drive is applied, no X-rays are generated. <i>Note: This test also provides a means to differentiate a generator problem from an HV cable or X-ray tube problem by running it with or without HV cables plugged into the HV tank.</i> The following components must be functional to execute this test: • Generator input line in an acceptable range (380V-10% to 480V+10% for 3-phase AC input) • PPC kV control board alive and running : S0-S7 LEDs are lit successively or a combination of them blink • Inverter gate_cmd board DC supply present: DS300 neon is lit • Inverter Quad Snubber board DC supply present: DS1-DS2 leds are lit • Inverter Gate Command diagnostic passed without failure • Inverter in short circuit diagnostic passed without failure

Test	Description
GEN_DIAG_ROTATOR	The purpose of this test is to drive the rotation inverter(s) in high speed mode (for application supporting high speed mode) and low speed mode on all the tubes connected to the Generator in order to identify a faulty rotation FRU or a faulty dephasing capacitor FRU or a wrong connection between Rotation PCB, HEMIT (only for NP++) and tube. The following components must be functional to execute this test: • PPC kV Control PCB alive and running: S0-S7 LEDs are lit successively or a combination of them blink • Rotation PSB alive and running: DS5 Led blinking • Rotation DC supply present: DS7 neon is lit • Cabling between Rotation PCB and tube checked (including HEMIT connections for NP++ only) The following sequence runs in low speed mode and then in high speed mode (if high speed mode allowed): • acceleration (time depends on tube type) • 2s run • brake (time depends on tube type) There is 2s stop time between each speed mode. During the test, the rotation safeties are checked the same way as they are in application mode.

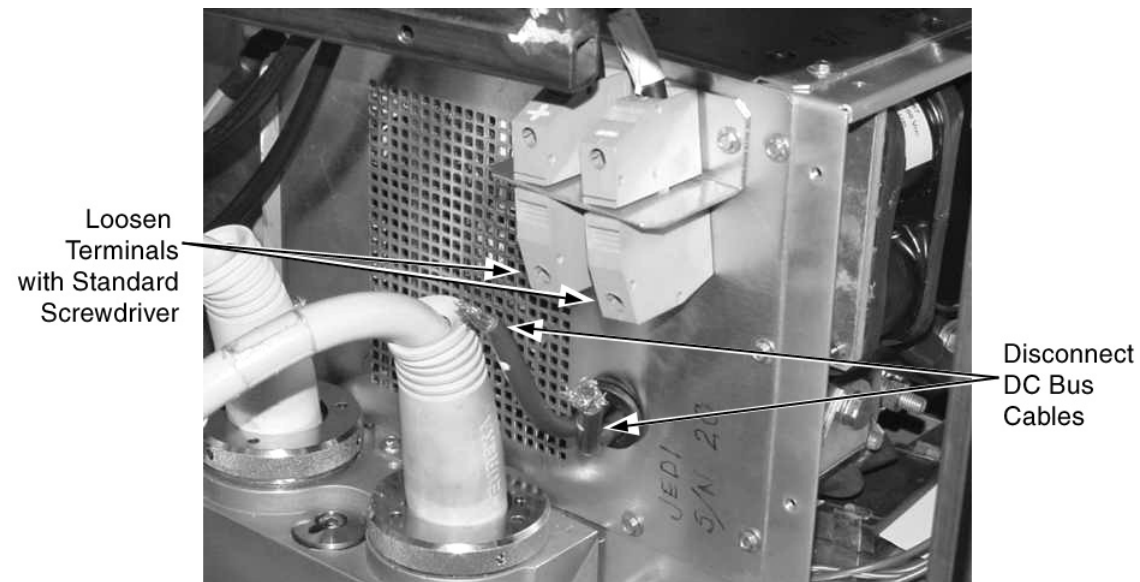
Test	Description
GEN_DIAG_HEATER	The purpose of this test is to drive the heater inverter(s) on both filaments and all the tubes connected to the Generator in order to identify a faulty heater FRU or a wrong connection between heater board, HV Tank and tube(s). The following sequence runs on the small focus and then on the large focus: • 5 seconds preheat • 0,4s boost • 5s heat (focal spot max current - 1Amp) There is 10s stop time between each focal spot run. During the test , the heater safeties are checked the same way than in application mode. The following components must be functional to execute this test: • PPC kV control board alive and running: S0-S7 LEDs are lit successively or a combination of them blink • Heater board alive and running: DS1 and DS2 Leds are lit successively • Heater DC supply present: DS3 Led is lit
GEN_DIAG_AEC	The purpose of this test is to drive the AEC function in order to identify a faulty AEC, IF or PPC kV Control PCB FRU or a bad connection between the AEC PCB and Ion Chambers. The following components must be functional to execute this test: • Application mode without AEC mode is running properly • PPC kV control board alive and running: S0-S7 LEDs are lit successively or a combination of them blink • Cabling between IF board, AEC board and ionization chambers checked.

Gate CMD Test (Requires Operator Intervention)

1. Remove AC power from the system.
2. Measure the DC Bus and verify that the voltage has decayed to a safe level before performing the next step.

Danger: ***Failure to verify a safe DC Bus voltage may result in serious injury or death.***

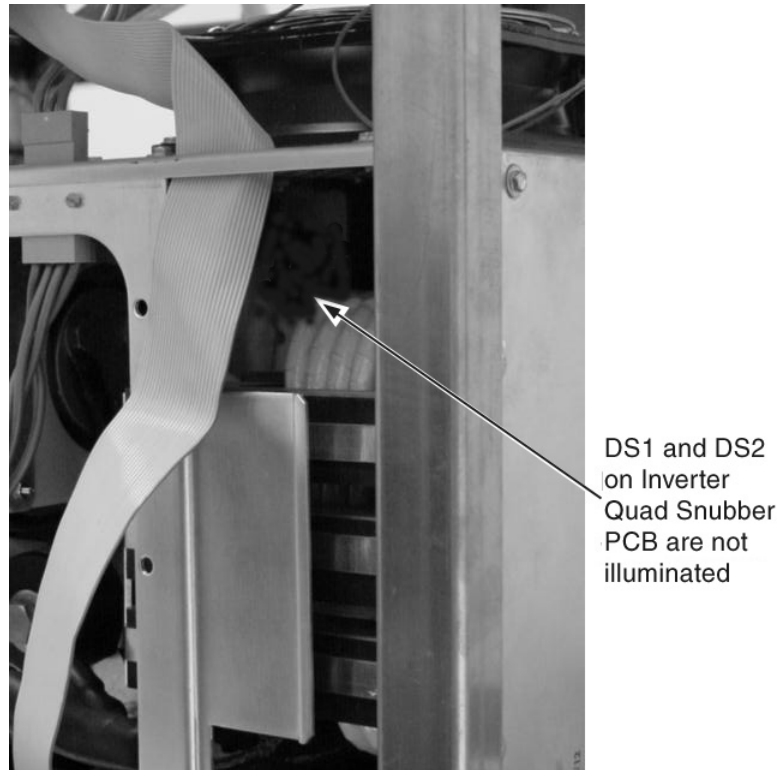
3. Disconnect the 2 DC bus cables between AC/DC board and Resonant Circuit Power Components in Inverter.



Disconnected DC Bus Cables shown

4. Power on the System.

5. Perform the Setup instructions provided at the beginning of this document.



View from front, diagonally up, to the top of the Quad Snubber PCB

6. Verify that the DS1-DS2 LEDs on Inverter Quad Snubber PCB are not illuminated.
7. Click the Run button beside the Gate Cmd diagnostic and verify:
 - No errors are reported on the operator console
 - Inverter Gate Cmd PCB LEDs DS101, DS102, DS201, DS202 are illuminated.

- IGBTs gate drive supply is working properly
8. Press and hold the exposure switch and then click the OK button.
 9. During the “exposure,” verify:
 - No errors are reported on the operator console
 - Inverter Gate Cmd PCB LEDs DS100 and DS200 are illuminated.
 - IGBTs gate drive is working properly.
 10. Release the exposure switch when the test completes.
 11. Remove power to the system.
 12. Measure the DC Bus and verify that the voltage has decayed to a safe level before performing the next step.

Danger: ***Failure to verify a safe DC Bus voltage may result in serious injury or death.***

13. Reconnect the 2 DC bus cables.

If the test fails, refer to the following troubleshooting table. Error codes are reported on the X-ray Control Console (Decimal) and Utility Suite Log Window (Hexadecimal). Refer to the 2800 Service Manual for a *comprehensive* list of error codes that are reported by the Generator.

Error	Conclusion
DS1-DS2 lit	Check that DC bus cables have been removed
DS300 neon off	Check the gate_cmd supply cable between AC/DC and gate_cmd board
0309/ 0310/ 0311/ 0312/ 0313/ 0314/ 0319/ 0323/ 0324 (hex)	Check that DC bus cables have been removed. If yes, replace PPC kV control board
0320h	If problem persists, replace PPC kV control board
0501h	PPC kV control board or inverter fault, replace PPC kV control board first
0503h 0504h	PPC kV control board or inverter fault, replace PPC kV control board first

Error	Conclusion
DS101 / DS102 / DS201 / DS202 One LED off while no error reported	Replace inverter
DS100 and/or DS200 LEDs off	Check cabling between PPC kV control, HV Tank and Gate Cmd board. If cabling is right, PPC kV control board or inverter fault, replace PPC kV control board first.

Inverter - In Short Circuit Test (Requires Operator Intervention)

Pre-requisites:

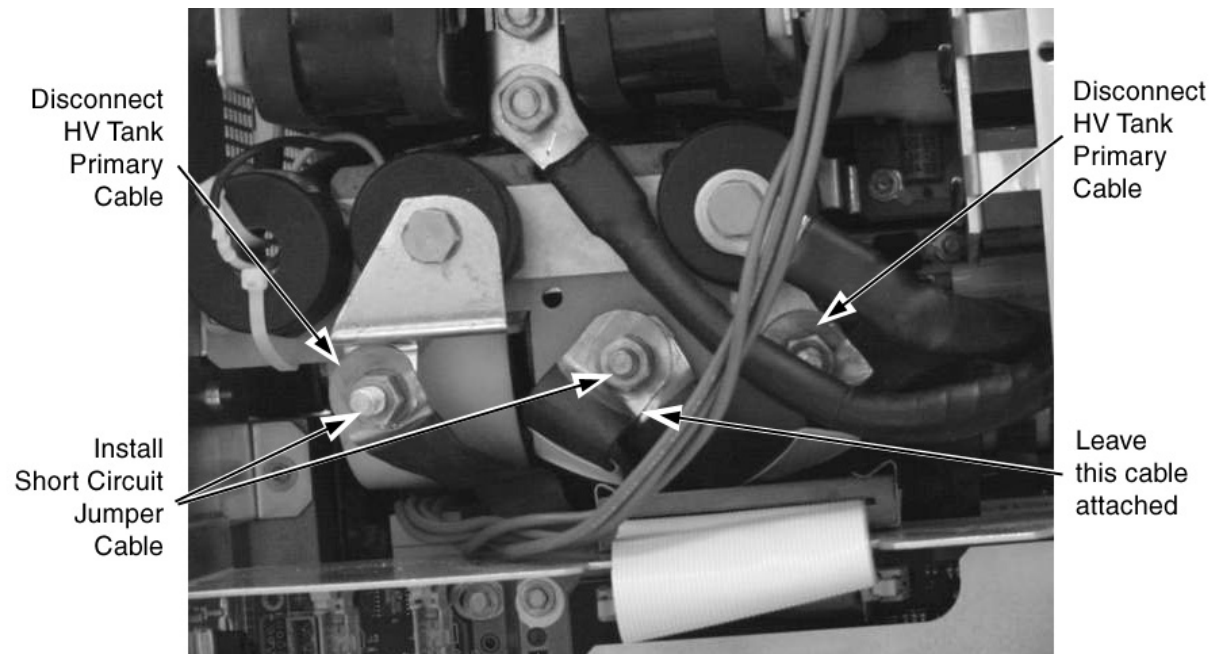
- Generator input line in an acceptable range (380V-10% to 480V+10% for 3-phase AC input).
- PPC kV Control PCB alive and running: S0-S7 Leds are lit successively or a combination of them blink.
- Inverter Gate_Cmd PCB DC supply present: DS300 neon is lit.
- Inverter Quad Snubber PCB DC supply present: DS1-DS2 led are lit.
- Inverter Gate command diagnostic passed without failure.

Sequence:

1. Remove AC Power from the system.
2. Measure the DC Bus and verify that the voltage has decayed to a safe level before performing the next step.

Danger: ***Failure to verify a safe DC Bus voltage may result in serious injury or death.***

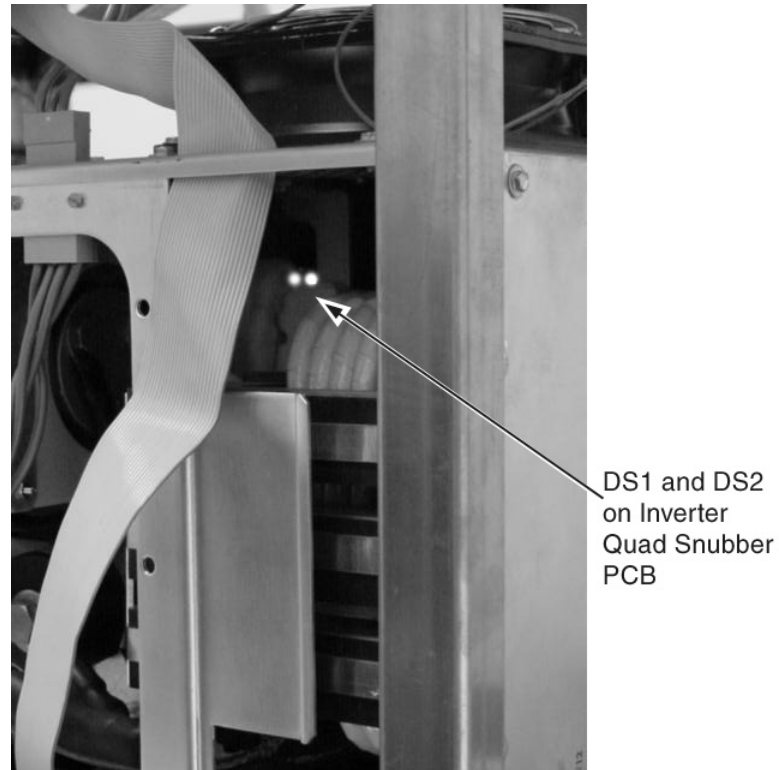
3. Disconnect the HV Tank primary cables from the inverter (see photo).
4. Install the short circuit jumper (cable) included in the first aid kit (GE P/N 2217057) between the two points shown in the photo.



Installing Short Circuit Jumper Cable

5. Power on the System.
6. Perform the Setup instructions provided at the beginning of this document.

7. Verify that DS1-DS2 LEDs on the Inverter Quad Snubber PCB are lit



View from front, diagonally up, to the top of the Quad Snubber PCB

8. Verify that the DS300 neon on Inverter Gate Cmd PCB is illuminated.
9. Click on the Run button beside the Inverter Diagnostic to start the test and verify that no error is reported on the operator console.
10. Press the exposure switch (500ms exposure is taken).

11. Release the exposure switch.
12. Verify no error is reported on the X-ray Control Console or Utility Suite Log Window.
13. After exiting the test, remove power from the System.
14. Measure the DC Bus and verify that the voltage has decayed to a safe level before performing the next step.

Danger: ***Failure to verify a safe DC Bus voltage may result in serious injury or death.***

15. Connect the HV Tank primary cables.
16. Remove the short circuit jumper (cable).

Error reporting

If test fails refer to the following troubleshooting table. Error codes are reported on the X-ray Control Console (decimal) and Utility Suite Log Window (Hexadecimal). Refer to the 2800 Service Manual for a *comprehensive* list of error codes that are reported by the Generator.

Error	Conclusion
DS1-DS2 LEDs off	Check that DC bus cables between AC/DC and inverter
DS300 neon off	Check the gate_cmd supply cable between AC/DC and gate_cmd PCB
0309/ 0310/ 0319/ 0324 (hex)	Check that HV Tank primary cables have been removed. If yes, replace PPC kV Control PCB
0313/ 0320 (hex)	Replace Inverter or PPC kV Control PCB

Error	Conclusion
0312h	If ILR current not detected: 1. Power off the Generator. Wait until all neons are off 2. Check that the inductors are correctly connected. If yes: 3. Disconnect the currents transformers to gate_cmd PCB cable. Check that the serial current transformer impedance is 0. If no: replace capacitor set. Else: 4. Check that inverter capacitors (capacitors set) are not broken. If yes, replace the capacitor set. Else: 5. Check that the Gate_Cmd to HV Tank cable and HV Tank to PPC kV Control cables are correctly connected. If yes : 6. Disconnect the HV Tank to PPC kV Control cable. Check that the impedance between pin-20 and pin-21 of J2 of HV Tank is 5 Ohms. If not, replace inverter. If yes, replace PPC kV Control PCB. 7. Reconnect all the cables

Error	Conclusion
0311h	If ILP current not detected: 1. Power off the Generator. Wait until all neons are off. 2. Check that the parallel inductor is correctly connected. If yes: 3. Check that the parallel inductor impedance is 0 Ohms. If no: replace inverter. If yes: 4. Check that inverter capacitors (capacitors set) are not broken. If yes, replace the capacitor set. Else: 5. Disconnect the current transformer to Gate_Cmd board cable. Check that the parallel current transformer impedance is 0. If no: replace the capacitor set. Else: 6. Check that the Gate_Cmd to HV Tank cable and HV Tank to PPC kV control cables are correctly connected. If yes : 7. Disconnect the HV Tank to PPC kV control cable. Check that the impedance between pin-20 and pin-21 of J2 of HV Tank is 3.3 Ohms. If no replace the inverter. If yes : replace PPC kV Control Board. 8. Reconnect all the cables

Error	Conclusion
0323h	If ILP and ILR currents not detected: 1. Check the -15V (Led DS1) on PPC kV Control Board. 2. If it is not lit, refer to “other failures” section. Else : 3. Power off the Generator. Wait until all neons are off 4. Check that the currents transformers (capacitor set) to Gate_Cmd board cable is correctly connected. If yes : 5. Check that the inverter inductors are correctly connected. If yes : 6. Check that HV Tank is correctly connected to the capacitors set. If yes : 7. Check that the Gate_Cmd to HV Tank cable and HV Tank to PPC kV control cables are correctly connected. 8. If yes, replace the inverter 9. Reconnect all the cables
0314h	If ILR current resonant frequency is lower than expected: 1. Power off the Generator. Wait until all neons are off 2. Check that the inductors are correctly connected. If yes: 3. Check that inverter capacitors (capacitor set) are not broken. If yes: replace the capacitor set. Else: 4. Disconnect the currents transformers to Gate_Cmd Board cable. Check that the parallel current transformer impedance is 0. If no: replace the capacitor set. Else: replace PPC kV Control PCB. 5. Reconnect all the cables
0501/ 0503/ 0504/ 0505 (hex)	Replace Inverter or PPC kV Control PCB

Noload KV Test

This test requires operator intervention.

CAUTION: If you have executed any Workstation tests, reboot the system before performing Table/Generator tests.

1. Perform the Setup instructions provided at the beginning of this document.
2. Select UTG2800 Tests from the Node Window.
3. Select the GEN Generator tab at the bottom-left of the Test Window.

Note: If the Disable ALL Tabs Tests checkbox is selected, the tests are disabled.

4. Click the Run button beside the NOLOAD KV test.

Note: To stop testing, click the STOP button

5. Press and hold the X-ray Switch and click OK button in the test window.
6. Release the X-ray Switch when the test is completed.
7. View the test results in the Log Window.
8. If a failure is indicated refer to the error codes in the following table and perform the actions described there.
9. Failed tests can be executed individually by clicking the Run button beside the test.

Note: To clear the results, click the Clear Results button

Error Codes

Refer to the 2800 Service Manual for a *comprehensive* list of error codes that are reported by the Generator. Error codes are reported on the X-ray Control Console (decimal) and Utility Suite Log Window (Hexadecimal).

Rotor Test

This test requires no operator intervention.

CAUTION: If you have executed any Workstation tests, reboot the system before performing Table/Generator tests.

1. Perform the Setup instructions provided at the beginning of this document.
2. Select UTG2800 Tests from the Node Window.
3. Select the GEN Generator tab at the bottom-left of the Test Window.

Note: If the Disable ALL Tabs Tests checkbox is selected, the tests are disabled.

4. Click the Run button beside the Rotor test.

Note: To stop testing, click the STOP button

5. View the test results in the Log Window.
6. If a failure is indicated refer to the error codes in the following table and perform the actions described there.
7. Failed tests can be executed individually by clicking the Run button beside the test.

Note: To clear the results, click the Clear Results button

Error Codes

Refer to the 2800 Service Manual for a *comprehensive* list of error codes that are reported by the Generator. Error codes are reported on the X-ray Control Console (decimal) and Utility Suite Log Window (Hexadecimal).

Heater Test

This test requires no operator intervention.

CAUTION: If you have executed any Workstation tests, reboot the system before performing Table/Generator tests.

1. Perform the Setup instructions provided at the beginning of this document.
2. Select UTG2800 Tests from the Node Window.
3. Select the GEN Generator tab at the bottom-left of the Test Window.

Note: If the Disable ALL Tabs Tests checkbox is selected, the tests are disabled.

4. Click the Run button beside the Heater test.

Note: To stop testing, click the STOP button

5. View the test results in the Log Window.
6. If a failure is indicated refer to the error codes in the following table and perform the actions described there.
7. Failed tests can be executed individually by clicking the Run button beside the test.

Note: To clear the results, click the Clear Results button

Error Codes

Refer to the 2800 Service Manual for a *comprehensive* list of error codes that are reported by the Generator. Error codes are reported on the X-ray Control Console (decimal) and Utility Suite Log Window (Hexadecimal).

AEC Test

This test requires no operator intervention.

CAUTION: If you have executed any Workstation tests, reboot the system before performing Table/Generator tests.

1. Perform the Setup instructions provided at the beginning of this document.
2. Select UTG2800 Tests from the Node Window.
3. Select the GEN Generator tab at the bottom-left of the Test Window.

Note: If the Disable ALL Tabs Tests checkbox is selected, the tests are disabled.

4. Click the Run button beside the AEC test.

Note: To stop testing, click the STOP button

5. View the test results in the Log Window.
6. If a failure is indicated refer to the error codes in the following table and perform the actions described there.
7. Failed tests can be executed individually by clicking the Run button beside the test.

Note: To clear the results, click the Clear Results button

Error Codes

Refer to the 2800 Service Manual for a *comprehensive* list of error codes that are reported by the Generator. Error codes are reported on the X-ray Control Console (decimal) and Utility Suite Log Window (Hexadecimal).

UXP2800 Tests

Review the test descriptions, perform the diagnostic tests and if a failure occurs refer to the error codes and perform the actions described there.

Test Descriptions

The following table describes tests performed by the UXP Node in response to a command from the Service computer.

Test	Description
UXP Req. SW Ver	The Service computer may issue this command to request the UXP software version. The value of the software version is embedded in the UXP software when the software is built and cannot be altered.
UXP Return Pa	The Service computer may issue this command in order to determine if the UXP node is operational. Furthermore, this function may be used to implement a “ping” function to determine reliability of the Arcnet communications.

Diagnostic Testing

CAUTION: If you have executed any Workstation tests, reboot the system before performing Table/Generator tests.

1. Perform the Setup instructions provided at the beginning of this document.
2. Select UXP Tests from the Node Window.

Note: If the Disable ALL Tabs Tests checkbox is selected, the tests are disabled.

3. Click the Test button to execute all the checked tests.

Note: To stop testing, click the STOP button

4. View the test results in the Log Window.
5. If a failure is indicated refer to the error codes in the following table and perform the actions described there.
6. Failed tests can be executed individually by clicking the Run button beside the test.

Note: To clear the results, click the *Clear Results* button

Error Codes

The following error codes, are reported by the UXP node, in response to a command from the Service Computer.

Code	Message	Description	Action
2A01	Illegal UXP Cmd Received	The command received was not a legal command.	This indicates a possible software incompatibility between the Utility Suite and the System Software. Please check to see that the versions are compatible.
2A02	Illegal UXP Cmd Received	The command received by the UXP contains an invalid code.	This indicates a possible software incompatibility between the Utility Suite and the System Software. Please check to see that the versions are compatible.
2A03	UXP System Failure	Refer to the error message displayed on the Control Panel VFD.	Obtain the error message from the VFD and refer to the Diagnostics section of the 2800 Service Manual for further troubleshooting.

WS (Workstation) Tests

Review the overview, perform the diagnostic tests and if a failure occurs refer to the error codes and perform the actions described there.

Diagnostic Testing

The Workstation components that can be tested with these diagnostics are the System Interface PCB, Video Controller PCB, Image Processor PCB, Display Controller/Adapter PCB, Cine Disk, IDE Hard Disk and FluoroTrak. Test selection is dependant upon which version of Image Processor is installed in the Workstation.

Executing Tests Automatically

The Utility Suite software will auto-detect the Image Processor version and select (place a check mark beside the appropriate test) the correct tests to execute. This is accomplished when Diags are initially selected.

1. Perform the Setup instructions provided at the beginning of this document.
2. Select WS Tests from the Node Window.
3. Click the Test button to execute all the tests,.

Note: Clicking the Test button will execute all of the checked tests on each tab of the Tab Window. Tests will be executed in sequence according to the tab listing from left to right.

Executing Tests Manually

If the auto-detect feature fails to detect the version of Image Processor installed, you can manually verify the IP version by checking the PCI Devices list and manually selecting tests.

Checking PCI Devices

1. Perform the Setup instructions provided at the beginning of this document.
2. Select PCI Devices from the Node Window.
3. Verify, based on the current system's configuration, that all PCI devices are listed on the screen. PCI devices are dependant upon the configuration of the system and may vary.
4. If any PCI devices are missing from the list, remove power and reseal the device (PCB) that is missing from the list. Also check all associated cables.
5. If any devices are listed as questionable, remove power and reseal the "over-the-top" cables.
6. Reboot the system and check the PCI Devices list again.
7. Make a note of the last four digits of the Image Processor's (IP) part number.

Workstation Diagnostic Tests

1. Perform the Checking PCI Devices subsection.
2. Select WS Tests from the Node Window.
3. Select tests for each Test Window tab based on the information in the following table:

Tab	If this IP version is installed...	Select Test...
System Interface	Not IP dependant	System Interface test batch macro
Video Controller	Not IP dependant	Video Controller test batch macro
Image Processor	00-879018 = Image Processor Stage 1 (IP S1)	Image Processor IP S1
	00-883283 = Image Processor Stage 3 (IP S3)	Image Processor IP S3
	00-883807 = Image Processor Stage 4 (IP S4)	Image Processor IP S4
Display Adapter	00-879018 = Image Processor Stage 1 (IP S1)	DA Test Batch Macro

Tab	If this IP version is installed...	Select Test...
	00-883283 = Image Processor Stage 3 (IP S3)	DA Test Batch Macro
	00-883807 = Image Processor Stage 4 (IP S4)	DA Test w/IP S4 test
Cine Bridge	00-879018 = Image Processor Stage 1 (IP S1)	Cine Bridge Test Batch Macro
	00-883283 = Image Processor Stage 3 (IP S3)	Cine Bridge Test Batch Macro
	00-883807 = Image Processor Stage 4 (IP S4)	Cine Bridge w/IP S4 test
IDE Hard-drive	00-879018 = Image Processor Stage 1 (IP S1)	IDE Hard-drive Test Batch Macro
	00-883283 = Image Processor Stage 3 (IP S3)	IDE Hard-drive Test Batch Macro
	00-883807 = Image Processor Stage 4 (IP S4)	IDE Hard-drive w/IP S4 test
FluoroTrak	Not IP Dependant	FluoroTrak test Batch Macro

4. After you have selected the correct test for each tab, click on the Test button to execute all the tests.

Note: If the Disable ALL Tabs Tests checkbox is selected, then the tests in other tab windows are disabled.

Note: To stop testing, click the STOP button

4. Pass/fail results are displayed in the Node Window and Test Window. Workstation macro failures and line number failures are listed in the Log Window.
5. If a failure occurs evaluate the macro failure to determine the most likely problem. The following example will help you understand how to evaluate macro failures:

MACRO FAIL - line 185 of C:\DIAG\CB\CBACQ.M01

First, see what component was being tested. You can determine this information from the Log Window. Then, note the subdirectory that contained the macro that failed. The subdirectory in the example provided indicates that a Cine Bridge macro (CB\CBACQ.M01) failed. The most likely problem is that either the component being tested failed, the component indicated in the subdirectory failed, or the communication between the two components failed.

6. After you have determined the components and cables that may be the cause of the problem, remove power to the system and verify all electromechanical connections by reseating the PCBs and cables associated with the components. Reseat connectors of cables at both ends.
7. Reboot the system and rerun the tests.
8. If the same test fails again, refer to the *Error Codes* and *Workstation Troubleshooting* sections that follow. You should also refer to Interconnect Diagrams, Functional Block Diagrams and other service information provided on the Advanced Service CD.

Note: Failed tests can be executed individually by clicking the Run button beside the test.

Test Descriptions

The WS Tests consist of macros, which are executed by batch files. Both macros and batch files exist in directories on the Workstation hard-drive. Naming conventions for the directories are:

- C: \ 9800 \ DIAG \ SI** — System Interface PCB
- C: \ 9800 \ DIAG \ VC** — Video Controller PCB
- C: \ 9800 \ DIAG \ IP** — Image Processor PCB
- C: \ 9800 \ DIAG \ DC** — Display Controller (Adapter)
- C: \ 9800 \ DIAG \ CB** — Cine Bridge
- C: \ 9800 \ DIAG \ DA** — Display Adapter
- C: \ 9800 \ DIAG \ IMG** — Displayable images targeted at IP's Image mem
- C: \ 9800 \ DIAG \ BIN** — Binary files for all PCBs (e.g. look-up table data)

The filename extension of all batch macros is “. Bxx” where “xx” equals the version number, e.g. B03 equals version 0.3.

All macros use the filename extension “. Mxx” where xx equals the version number.

Image files are defined as files designed to be copied into the Image Processor's Image memory for monitor display. Image files use the filename extension ". lxx" where xx equals the version number. All image files called by any macro file are held in the directory **C: \ 9800 \ DIAG \ IMG**.

Binary files are copied to memory devices such as look-up tables or crossbar switches but does not create a viewable image. Binary files have a ".Nxx" filename extension where xx equals the version number. All binary files for all PCBs are held in the directory **C: \ 9800 \ DIAG \ BIN**.

The Workstation electronics box contains 8 major components: Power Supply, Pentium Motherboard, System Interface PCB, Video Controller PCB, Image Processor PCB, Display Controller an optional Cine Bridge PCB and the Control Panel with its own processor. All PCBs plug directly in to the Pentium Motherboard with the exception of the Control Panel Processor, which interfaces with the System Interface PCB via an RS-485 serial communications link. Those PCBs that plug into the Motherboard are tested by running a series of "macro files" located on the Workstation's system hard disk.

Macro files are DOS text script files residing on the system hard disk that include commands to test Workstation memory devices and load and save files from/to hard disk.

Batch macro files are DOS text files that list the names of macro files to be executed sequentially.

The Workstation has a system software module that interprets the commands contained in macro files and performs the appropriate "macro commands". This testing is performed at a very low level that provides access to each register and memory device located on the System Interface, Video Controller, Image Processor, Display Controller (or Display Adapter) and Cine Bridge PCB.

The Field Service Computer simply sends a command to the Workstation Node to execute a specified macro or batch macro. Upon detecting an error or upon successful completion, a single status packet is returned to the initiating node.

CAUTION: *Due to the very low-level memory access capabilities of macro commands, Workstation registers can be changed to a state that makes X-ray images invalid or non-existent. Therefore, when the Workstation executes a macro or batch, the Workstation automatically shuts down most software tasks including communication with the Arcnet nodes in the C-arm. This causes a "COMMUNICATION FAIL" message at the C-arm. This is a normal message. A communication failure at the C-arm causes all X-ray generation to terminate until the system power is turned off and then on. This failsafe ensures X-rays cannot be generated while the Workstation is running diagnostics. If diagnostic testing has been executed on the Workstation, reboot the system prior to testing the C-Arm (generator).*

WS Return Packet

The Service computer may issue this command in order to determine if the Workstation node is operational. Furthermore, this function may be used to implement a “ping” function to determine reliability of the Arcnet communications.

System Interface (9800 \ DIAG \ SI) Macros

System Interface macros and batch files are contained in the **C: \ 9800 \ DIAG \ SI** subdirectory on the system hard disk. The macros contained in this directory are designed to test Workstation-wide signals (e.g. power supplies, temperature and light sensors) rather than the System Interface PCB itself.

Two batch macros are contained in the SI directory — “TEST_SI.Bxx” and “TESTC_SI.Bxx”. The “xx” represents the version number of the file.

TEST_SI.Bxx tests Workstation power, the light sensor and WS temperature. Power and temperature for the optional Cine Enclosure are not tested with this batch file. The following macro files are called by the batch:

SI\WS_PWR.Mxx	Tests Workstation DC voltages
SI\WS_HEAT.Mxx	Tests electronics enclosure temperature
SI\LIGHTSEN.Mxx	Tests WS light sensor

TESTC_SI.Bxx tests cine disk voltage on Cine Bridge PCB and Cine Disk Enclosure +5 and +12 VDC. Note that this batch tests only the cine supplies. Therefore, TESTC_SI.Bxx should be run prior to this batch to ensure all power supplies are good. This batch also tests temperature inside the enclosure. The following macro files are called by the batch:

SI\CINE_PWR.Mxx	Test cine subsystem DC voltages
SI\CINEHEAT.Mxx	Test cine disk enclosure temperature

Since failure of macro returns only the failed line number, the macros used to test power supplies will be summarized in this document (with line numbering added). **Note that these are revision 0.1 macros (*.M01 filenames).** If your system is using a different version, refer to that file.

Macro (Test)	Line #	SI Signal Name being tested:	Supply/tolerance being tested
WS_PWR.M01	30	IP_+3.3V_SEN	+3.3 V $\pm$ 5% @ Image Processor PCB
	37	IP_+5V_SEN	+5 V $\pm$ 5% @ Image Processor PCB
	44	DSPCNT_+3.3V_SEN	+3.3 V $\pm$ 5% @ Display Adapter PCB
	51	DSPCNT_+5V_SEN	+5 V $\pm$ 5% @ Display Adapter PCB
	58	VIDCNT_+3.3V_SEN	+3.3 V @ Video Controller PCB
	65	VIDCNT_+5V_SEN	+5 V $\pm$ 5% @ Video Controller PCB
	71	-12V	(see System Interface schematic)
	78	-12VMB	-12 $\pm$ 10% @ Motherboard
	85	+5VMB	+5 $\pm$ 5% @ Motherboard
	92	+12V	(see System Interface schematic)
	99	VCC	VCC $\pm$ 5% @ Motherboard
	106	+12VMB	+12 V $\pm$ 10% @ Motherboard
	134	CP_+12V_SEN	+12 V $\pm$ 10% feeding WS Control Panel
	141	CP_+5V_SEN	+5 V $\pm$ 10% feeding WS Control Panel
WS_HEAT.M01	33	TEMP_SEN_1	Electronics cabinet temperature sensor +10 C to +55 C
LIGHTSEN.M01	18	AMB_LIGHT_1	WS front panel light sensor – on dark end, a value of zero is allowed. Just under saturation is allowed on upper end. This test may detect a faulty sensor but not a disconnected sensor.
CINE_PWR.M01	23	4/30FPS_+3.3V_SEN	+3.3 V $\pm$ 5% @ Cine Bridge PCB
	34	4/30FPS_+5V_SEN	+5 V $\pm$ 5% @ Cine Bridge PCB
	41	PCIDA_+12V_SEN	+12 V $\pm$ 10% in optional cine enclosure
	47	PCIDA_+5V_SEN	+5 V $\pm$ 5% in optional cine enclosure

Macro (Test)	Line #	SI Signal Name being tested:	Supply/tolerance being tested
CINEHEAT.M01	34	TEMP_SEN_2	Optional cine enclosure +10 C to +55 C

Video Controller PCB (9800 \ DIAG \ VC) Macros

Batch/Macro File	Description
TEST_VC.Bxx	This macro provides Video Controller memory testing in three modes: with the default camera video source (50 Hz or 60 Hz) applied to the system, with an internal 50 Hz video crystal, and again with an internal 60 Hz video crystal. Upon completion of the batch macro, the Video Controller remains in 60 Hz (crystal on Video Controller PCB) mode. This testing methodology was chosen for two reasons: 60 Hz systems operate at higher frequencies than 50 Hz systems thereby providing a more strenuous test of memory. Also, using the on-board crystal likely eliminates a bad camera from causing a macro failure on a PCB down-stream from the Video Controller.

Image Processor PCB (9800 \ DIAG \ IP) Macros

Batch/Macro File	Description
TEST_IP.Bxx	The Image Processor macros are extremely complex and are typically difficult to troubleshoot. This burn-in test for the IP lasts about three minutes. Unfortunately, it is necessary to capture images on the Display Adapter (or Display Controller) to determine if the IP is operating properly. Therefore, a failure while testing the IP might actually be caused by the Display Adapter. When examining the filename of the failed macro, look for the letter combination “DA” or “DC” (standing for Display Adapter or Display Controller). For example, if “C:\9800\DIAG\IP\TDCCMP.M01” fails, the “DC” letter combination suggests the test uses the Display Controller. Therefore, the failure could be either the IP or DC.

Display Adapter PCB (9800 \ DIAG \ DA) Macros

Batch/Macro File	Description
TEST_DA.Bxx	Some circuitry on the Display Adapter can only be tested by pre-loading the Image Processor with known images. Therefore, the possibility exists that a failure of a DA macro is actually caused by the IP. However, if the IP tests were previously run and passed, that possibility is slim. The failure is most likely an actual Display Adapter failure.

Display Controller PCB (9800 \ DIAG \ DC) Macros

Batch/Macro File	Description
TEST_DC.Bxx	This PCB is the predecessor to the Display Adapter PCB and is tested in an identical manner. The only difference is some binary files have slightly different values. The failure modes of this PCB are the same as described for the Display Adapter.

Cine Bridge PCB (9800 \ DIAG \ CB) Macros

Batch/Macro File	Description
TEST_CB.Bxx	All memory devices on the Cine Bridge can be tested without side effects from the Image Processor. Therefore, any failure of the "C:\9800\DIAG\CB\CBMEM2.Mxx" macro indicates a memory failure on the Cine Bridge PCB. However, a failure of macros using the Image Processor while acquiring and playing back images from the Cine Bridge PCB, ("CB\CBACQ3.Mxx" and "CB\CBPLYBK4.Mxx") could indicate a failure of the IP PCB (or interconnecting cable) as well as a Cine Bridge failure.

System Hard Disk (9800 \ DIAG \ HD) Macros

Batch/Macro File	Description
TEST_HD.Bxx	The macro called by the batch file ("C:\9800\DIAG\HD\HD.M01") simply loads the Image Processor's Image with a 4 megabyte random pattern, saves the file to disk, reads the file from disk and compares the file saved to disk with the file read from disk.

Error Codes

Workstation Node Error Codes (4001 — 4002)

Code ₍₁₆₎	Message	Description	Action
4001	Illegal WS Command Received	The command received was not a legal command nor was it a Super-X command.	This indicates a possible software incompatibility between the Utility Suite and the System Software. Please check to see that the versions are compatible.
4002	Illegal WS Cmd Received	The Super-X sub-command received by the Workstation node contains an invalid code.	This indicates a possible software incompatibility between the Utility Suite and the System Software. Please check to see that the versions are compatible.

Utility Suite Error Codes (5001 — 500B)

Code ₍₁₆₎	Message	Description	Action
5001	Response Timeout Error	The node running the specified test did not respond in the time allotted by the Utility Suite.	Verify communications connections between the service node and the node under test.

Code ₍₁₆₎	Message	Description	Action
5002	Response Out Of Sync	The response packet received by the Service Computer did not match the command issued by the Service Computer.	Verify communications connections between the service node and the node under test. Network may not be stable or network recons are occurring.
5003	Illegal Command From Host	This error code indicates a failure of the Utility Suite software — not the system under test.	This indicates a possible software incompatibility between the Utility Suite and the System Software. Please check to see that the versions are compatible.
5004	Echo Arcnet Packet Error	The Service Computer issues an Arcnet “echo packet” command to each node of the system under test after the system has been allowed time to boot. That test verifies all nodes (processors) in the system are running and communicating via Arcnet. This error code indicates the associated node’s processor is not operating properly.	Verify communications connections between the service node and the node under test.

Code ₍₁₆₎	Message	Description	Action
5005	Measured Technique Failure	One or more of the measured X-ray technique values (kV, mA/mAs or VLI) is not within specification. One or more of the following three error codes will accompany this code.	This indicates a possible calibration problem. Verify that the generator X-ray calibration is correct and rerun the test.
5006	KV Failure	Measured kV is out of tolerance.	This indicates a possible calibration problem. Verify that the generator X-ray calibration is correct and rerun the test.
5007	MA Failure	Measured mA (or mAs for FILM mode) is out of tolerance.	This indicates a possible calibration problem. Verify that the generator X-ray calibration is correct and rerun the test.
5008	VLI Failure	Measured VLI is out of tolerance.	This indicates a possible calibration problem. Verify that the generator X-ray calibration is correct and rerun the test.

Code ₍₁₆₎	Message	Description	Action
5009	Arcnet Buffer Overrun	This error occurs when any Arcnet node (WS, SRV, GEN or FFB) resets or is lost after the system under test has booted up. A reset or loss of any node on Arcnet causes several packets to be “broadcast” to all nodes thereby overrunning the Arcnet packet buffer in the Service Computer. A node reset or loss represents a serious system error and may indicate power problems or blown circuit breakers or fuses.	Verify communication connections between the service node and the node under test. Network may not be stable or network recons are occurring.
500A	Invalid Port Num	This error code indicates a failure of the Service Computer software — not the system under test. Contact Test Engineering.	This indicates a possible software incompatibility between the Utility Suite and the System Software. Please check to see that the versions are compatible.
500B	WS Macro Error	The current macro that is executing has encountered an error and the test has stopped. The error information may be found in the error log window.	Look at the subdirectory in the path information of the error window. See previous sections in this document for specific diagnostic methods depending on the information stored in the path. There are different instructions for each of the following: SI, IP, DA, DC, and VC.

Workstation Diag (Macro) Error Codes (-1 — -150)

The Workstation generates the following codes when running macros located on the system hard disk. At the Service Computer, the following messages are sub-messages of the failure “**WS Macro Error**” (error code 500B). The following macro error messages can be easily recognized by the fact that they are negative value error codes.

When analyzing these error codes, note both the component that was currently being tested and the subdirectory described in the failed macro. The potential problem is most likely one of these two components or the communication in-between.

Code ₍₁₀₎	Message	Description
-1	UTL Invalid bus width parameter during MemCpy(). Check MemDef.txt file	MemDef.txt file corrupt on hard disk. Reload all macro files.
-28	EDT The PCI bus device specified is not installed.	A PCB being tested wasn't found on the PCI bus. The PCB may be bad or just require re-seating in the motherboard or backplane.
-63	INI Not enough memory to hold memory definition file (memdef.txt)	System memory was unavailable for loading and running the macro programs. Check system motherboard for required memory.
-64	INI Failure in M_sFillMemDefArray	MemDef.txt file corrupt on hard disk. Reload all macro files.
-81	MAC Macro file not found.	Corrupt batch macro file or macro file is missing from system hard disk. Reload all macro files
-84	MAC Unrecognized keyword (command) in macro file.	Corrupt macro file. Reload all macro files
-85	MAC Unable to allocate temporary memory to hold macro file.	System memory was unavailable for loading and running the macro programs. Check system motherboard and/or Single Board Computer for required memory.

Code ₍₁₀₎	Message	Description
-88	MAC File specified by macro's READ_DISK command not found.	Corrupt macro file or binary or image file is missing from system hard disk. Reload all macro files, binary files (DIAG\BIN) and image (DIAG\IMG) files
-89	MAC Unable to open macro data file.	Corrupt macro file or binary or image file is missing from system hard disk. Reload all macro files, binary files (DIAG\BIN) and image (DIAG\IMG) files
-91	MAC Can't create macro's WRITE_DISK data file. Verify valid filename.	Corrupt macro file or system hard disk is full.
-92	MAC Macro file data save size doesn't match MemDef size.	Corrupt macro file or MemDef.txt file. Reload all macro files
-94	MAC Invalid keyword found in macro file.	Corrupt macro file. Reload all macro files
-95	MAC Memory definition number in macro command larger than total MemDefs.	Corrupt macro file or MemDef.txt file. Reload all macro files
-96	MAC File size in macro's READ_DISK is not the same size as MemDef.Size.	Corrupt macro file or MemDef.txt file. Reload all macro files
-97	UTL Address specified in POKE command exceeds memory size.	Corrupt macro file or MemDef.txt file. Reload all macro files
-98	UTL Address specified in PEEK command exceeds memory size.	Corrupt macro file or MemDef.txt file. Reload all macro files
-99	UTL Device specified in POKE command not installed.	A PCB being tested wasn't found on the PCI bus. The PCB may be bad or just require re-seating in the motherboard or backplane.
-100	UTL Device specified in PEEK command not installed.	A PCB being tested wasn't found on the PCI bus. The PCB may be bad or just require re-seating in the motherboard or backplane.

Code ₍₁₀₎	Message	Description
-102	MAC Single transfer compare error listed above.	Normal error message if two values in memory should have matched but don't. The PCB under test has failed.
-103	UTL Error comparing byte values.	Normal error message if two bytes (8-bit values) in memory should have matched but don't. The PCB under test has failed. A failure here indicates a register mismatch (not a large block of RAM memory).
-104	UTL Error comparing word values.	Normal error message if two words (16-bit values) in memory should have matched but don't. The PCB under test has failed. A failure here indicates a register mismatch (not a large block of RAM memory).
-105	UTL Error comparing dword values.	Normal error message if two dwords (32-bit values) in memory should have matched but don't. The PCB under test has failed. A failure here indicates a register mismatch (not a large block of RAM memory).
-106	MAC Macro LOOP_ENABLE command with invalid number of loop counts.	Corrupt macro file or MemDef.txt file. Reload all macro files
-109	GBL Unable to allocate memory for LclSrc.	System memory was unavailable for loading and running the macro programs. Check system motherboard and/or SBC for required memory.
-115	MEM Address boundary test failed.	Normal error message if the RAM under test has shorted or open address lines. The PCB under test has failed.
-118	INI MemDef.Txt file not found.	MemDef.txt file was not found on the system hard disk. Reload all macro files.
-119	INI Total non-commented lines in memdef.txt not a multiple of MDEF.	Corrupt MemDef.txt file. Reload all macro files

Code ₍₁₀₎	Message	Description
-121	MAC Not enough or too many parameters found for specified macro command.	Corrupt macro file. Reload all macro files
-122	MAC POST_MSG command in macro file has no message	Corrupt macro file. Reload all macro files
-123	MAC Address offset specified in macro PEEK larger than MemDef.Size.	Corrupt macro file or MemDef.txt file. Reload all macro files
-124	MAC Address offset specified in macro POKE larger than MemDef.Size.	Corrupt macro file or MemDef.txt file. Reload all macro files
-125	MAC Address offset specified in macro WAIT larger than MemDef.Size.	Corrupt macro file or MemDef.txt file. Reload all macro files
-126	MAC Address offset specified in macro WAIT_NOT larger than MemDef.Size.	Corrupt macro file or MemDef.txt file. Reload all macro files
-127	MAC Mask value of zero detected in macro WAIT command. Macro will lock.	Corrupt macro file or MemDef.txt file. Reload all macro files
-128	MAC Mask value of zero detected in macro WAIT_NOT (no wait will occur).	Corrupt macro file or MemDef.txt file. Reload all macro files
-136	GBL MemDef number passed to GBL_siAllocLcl() is invalid.	Corrupt macro file or MemDef.txt file. Reload all macro files
-137	INI MemDef.txt contains a def with the memory size element = 0.	Corrupt macro file or MemDef.txt file. Reload all macro files
-138	INI MemDef.txt contains a def with memory width not equal to 1, 2 or 4	Corrupt macro file or MemDef.txt file. Reload all macro files
-139	INI MemDef.txt contains a def with bus xfer width not equal to 1, 2 or 4	Corrupt macro file or MemDef.txt file. Reload all macro files
-145	Fill random function byte count less than 2	Corrupt macro file or MemDef.txt file. Reload all macro files

Code ₍₁₀₎	Message	Description
-146	MAC Batch macro filename not found.	Corrupt or missing macro file. Reload all macro files
-148	MAC Specified batch file contains too many macro filenames.	Corrupt macro file. Reload all macro files
-150	MAC Value contained in peek buffer is out of range.	Normal error message if a value being tested isn't within the specified range. This error most commonly occurs when testing power supply voltages, light sensors or temperature sensors where the value must be within a specified range.

Workstation Troubleshooting

Sytem Interface PCB Troubleshooting

If reseating PCBs and connectors associated with the System Interface subsystem has failed to correct the problem, these additional troubleshooting steps may help resolve the problem.

1. If WS_PWR.M01 failed, perform these tests and retest after each change:
 - A. Check the LEDs located on the DC Distribution PCB. There are three LEDs to represent +5, +12, and -12 VDC coming from the DC power supply. The other LEDs are labeled as to which subsystem they are attached and used to denote if voltage is present at the connector for each subsystem. If the three LEDs for incoming power are illuminated, and one of the LEDs for a subsystem is off, then check the appropriate fuse and replace if blown. A blown fuse in this section could mean either a shorted cable extending to the subsystem, or a fault in the subsystem itself. Disconnect the DC power cable at the appropriate subsystem and use an ohmmeter to check between the fuse and ground to help isolate the problem. Use the Interconnect Diagram to identify the appropriate cable assemblies and subcomponents.
 - B. If one of the incoming LEDs are off then troubleshoot back from connector J4 on the DC Distribution PCB to the DC power supply.

- C. Use a DMM to measure the DC voltage level at test points found on the DC Distribution PCB. Ensure the +5 VDC is adjusted to +5.15 with the test points as a reference. An adjustment pot for the +5 line is located on the DC power supply.
- 2. If WS_HEAT.M01 failed, perform these steps and retest after each change:
 - A. Verify that the AC fans B2 and B3, located at the bottom of the electronics enclosure are functioning.
 - B. If they are not running, check the cables to each fan and their connection at terminal block TB2-5 & 7 for 115 VAC.
 - D. Check the temperature sensor located on the DC Distribution PCB for obvious signs of damage. If damage is suspected replace the circuit board.
 - E. Reseat ribbon cable connector J5 on the System Interface PCB and connector J5 on the DC Distribution PCB.
 - F. If inadequate air flow into and out of the box is not suspected then replace the System Interface PCB #00-879056-0x.
- 3. If LIGHTSEN.M01 failed, perform these steps and retest after each change.
 - A. Remove cable 00-879428-XX from connector J6 of the System Interface PCB. Measure the resistance between pins 20 and 21. Change the amount of light entering the Light Sensor located in the IR Receiver module. The resistance will change according to the amount of light entering the device. If the resistance changes then the cables and the sensor are functioning. If the resistance is an open then perform a continuity check from pins 20 and 21 on up thru cable 00-879428-XX and 00-879475-XX to the IR Receiver 00-879673-XX. Replace any damaged cable. If it is ok then reseat connections. If the resistance did not change at all then replace the IR Receiver 00-879673-XX.
 - B. Replace the System Interface PCB 00-879056-XX.

Video Controller PCB Troubleshooting

If reseating the Video Controller PCB and connectors has failed to correct the problem, check and replace cables as necessary. If this does not correct the problem, replace the Video Controller and retest.

Image Processor PCB Troubleshooting

If reseating PCBs and connectors associated with the Image Processor has failed to correct the problem, these additional troubleshooting steps may help resolve the problem.

The following components can cause IP macros to fail:

Note: Assumes the generator is disconnected (so that Video Control sync signals are guaranteed stable) and the Host PC and PCI interface are okay

Order of Test/ Replacement	Component	Description
1	Cable	Video Controller - Image Processor (P4)
2	Cable	Display Adapter/Controller - Image Processor (P5)
3	PCB Asm	Video Controller PCB
4	PCB Asm	Display Adapter/Controller
5	Cable	Power to Image Processor (P3)

Display Adapter PCB Troubleshooting

If reseating PCBs and connectors associated with the Display Adapter has failed to correct the problem, these additional troubleshooting steps may help resolve the problem.

The following components can cause Display Adapter macros to fail:

Note: Assumes the generator is disconnected (so that Video Control sync signals are guaranteed stable), the Host PC and PCI interface are okay and the Image Processor macros passed okay.

Order of Test/ Replacement	Component	Description
1	Cable	Image Processor - Display Adapter/Controller (P9)
2	PCB Asm	Image Processor PCB

Cine Bridge PCB Troubleshooting

If reseating all PCBs and connectors associated with the Cine subsystem has failed to correct the problem, replace components in the following order. Retest after each item is replaced.

Order of Test/ Replacement	Component	Description
1	Cable	Cine Bridge to Image Processor (top side both boards)
2	PCB Asm	Image Processor PCB
3	PCB Asm	Cine Bridge PCB
4	Power Cable	Cine Bridge -- Cine Bridge to DC Distribution (top side)

If replacing the components in the table fails to correct the problem troubleshoot the Cine Disk system:

- Fibre Channel Serial cable
- Cine Bridge to Cine Backplane cable (component side both boards)
- Cine Disk Drives
- Cine Backplane PCB (component side both boards)